Solar Energy Systems

There are two basic types of solar energy installations that produce electrical power: photovoltaic (PV) systems and commercial concentrating solar power (CSP) systems. These can be combined with natural gas or other fossil fueled power systems to form hybrid systems. To work effectively, the solar installations require consistent levels of sunlight (solar insolation) and would be backed up with battery, thermal, or other forms of energy storage.

Solar insolation is a measurement that has become increasingly more accurate in evaluating specific sites for solar energy installations. Solar insolation is the amount of sunlight hitting an area on the surface of the earth over a specific period of time. The higher the exposure of sun measured on an annual basis, the more electrical power can be produced.

The quality of the solar resource, over a month or a year, is an important indicator in determining the viability of a site for commercial solar development. Other site attributes include access to available water for concentrated solar power steam generation and cooling, proximity to electric transmission facilities, and site slope. The most promising areas for solar energy development on public lands are in Arizona, southern California, Nevada, and New Mexico. Parts of Utah and Colorado also have excellent levels of solar insolation.

Photovoltaic Systems

PV systems use semiconductor materials similar to those in computer chips to capture the energy in sunlight and convert it directly into electricity. PV cells are electrically connected into a weather-tight module. These modules can be further connected to form an array which can include electrical connections, mounting hardware, power conditioning equipment, and batteries that store solar energy. The size of the array depends on the amount of sunlight and the needs of the customer. Large PV electrical generating systems have not generally been used for commercial utility applications due to the high upfront cost.

Most PV applications are small, use little or no land, and have minimal or no environmental impact since electricity created is generally used on-site or as part of an existing authorized use. They generally provide power to individual homes and small buildings. They are also found in rural areas on communication towers, water pumps, and road and traffic signs.

The environmental impact of small distributed PV systems is minimal, as they require no water for system cooling and generate no by-products. Most installations of solar PV systems are less than 5 kilowatts (kW) in capacity, and tend to be most cost-effectively applied in isolated locations where construction of electric transmission and distribution networks would be more costly. These types of solar PV systems will likely be installed on an existing facility or structure or as part of an existing authorization.

Concentrating Solar Power Plants

CSP plants are generally large systems that use mirrors to focus sunlight to create high temperatures. The high temperatures generated by the focused sunlight are used to generate electricity either by a heat engine causing gas to expand and move a piston or by a conventional power cycle using boiling water to create steam that turns a turbine. For a steam-driven CSP system, facilities include a solar collection system, a system for transferring the collected energy to a working fluid or to a storage system, and a system such as a turbo-generator for converting the thermal energy to electricity. Many of these power plants have a hybrid solar/fossil fuel capability that can be used during periods of low solar energy. Many also include thermal storage. These capabilities enable CSP plants to supply energy to a utility grid when it is most needed (day or night).

The lands having the best solar resources are usually arid or semi-arid. Unlike PV systems, CSP systems require sunlight that is not diffused by clouds. This limits their use to the West, with the southwest possessing some of the best solar energy resources.

There are currently three different types of centralized CSP systems: parabolic trough, solar "power tower", and solar dish. These systems require relatively flat land with slopes not exceeding three percent to accommodate the solar collectors. The area of land required depends on the type of plant, but it is about five acres per produced megawatt (MW). It is anticipated that a commercial scale CSP facility may be in the range of 100 MW or larger and will require in excess of 500 acres. This large land base requirement can involve significant surface disturbance with an associated potential impact on a variety of resources and resource uses on the public lands. These types of facilities also require roads, water, protection from gusty winds, and security fencing. Electricity generated is sold to the utility under a power purchase agreement.

Additional information on solar energy technology is available from the Department of Energy at http://www.eere.energy.gov/RE/solar.html or the National Renewable Energy Laboratory (NREL) at http://www.nrel.gov